GOULD

MANUAL PART NO.
80-OS245A

Petronics
petroleum electronic specialists
2441 McAllister,
Houston, Texas 77092

OS 245A

10 MHz DUAL TRACE OSCILLOSCOPE

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Introduction

The Gould OS245A Oscilloscope is a 10MHz dual trace instrument with a 8 x 10div display, each division being 0.8cm. It is designed for use in general purpose laboratory work, educational uses, TV and servicing applications, etc.

It features two identical channels with maximum sensitivities of 5mV/div and band-widths of d.c. to 10MHz. The two channels may be viewed separately, alternately at fast timebase speeds, or chopped at a 250kHz rate at low timebase speeds.

Particular attention has been paid to trigger performance, and the system used includes a variable trigger level control with bright line operation in the absence of a signal, or when the control is set outside the range of the input signal.

The instrument can also be used to provide a single trace X-Y display via the CH1(X) and the CH2(Y) input channels with full sensitivity adjustment on each channel.

Specification

Section 2

DISPLAY

4 in flat faced CRT with 8 x 10 division graticule, each division 0.8cm EHT 1.5kV.

Phosphor – P31, Long Persistence (P7) available as an option.

VERTICAL DEFLECTION

Two identical input channels, CH1 and CH2.

Bandwidth (–3dB) d.c. – 10MHz.

Sensitivity 5mV/cm to 20V/cm in 1-2-5 sequence.

Accuracy ± 5%

Input Impedence 1MΩ/approx. 28pF.

Input coupling DC-GND-AC.

Protection 400V DC or pk AC.

DISPLAY MODES

Single trace – CH1

Dual trace – Chopped or alternate modes automatically selected on timebase switch. 1ms/div and slower – chopped at approx. 250kHz 0.1ms/div and faster – alternate

X – Y Mode with CH1 input giving X deflection

CH2 input giving Y deflection

Bandwidth d.c. to 500kHz.

<3° phase shift at 20kHz.

HORIZONTAL DEFLECTION

Timebase Ranges 1μs per division to 0.5s per division in 18 ranges (1, 2, 5 sequence).

Uncalibrated variable control give >2.5:1 reduction in sweep speed.

Accuracy ±5%.

X Expansion x 5 and x10 expansion gives fastest sweep speed of 100ns per division.

Accuracy ± 5% except x10 expansion on fastest range when accuracy ± 20%.

TRIGGER

Variable level control with option of bright line in absence of input.

Source CH1, CH2 or External

Slope + or –

Coupling AC, AC fast, TV frame

Sensitivity	Internal <0.3 division	40Hz-1MHz
	approx 1 division	8Hz-10MHz
	External <1.5 volt	40Hz-1MHz
	approx 5 volts	8Hz-10MHz
	External Input impedence	100kΩ <10 pF.

ADDITIONAL FACILITIES

Gate Output 1.0V ± 3% from approx. 750Ω

Z mod Input a.c. coupled. Bandwidth 2Hz – 10MHz. 10V gives visible modulation

POWER

115V, 220V, 240V ± 10% a.c. 45-440Hz

ENVIRONMENTAL FEATURES

Operating Temperature Range 0–50°C (15°C to 35°C for full accuracy)

Humidity Constant operation at 40°C and 95% relative humidity. Intermittent operation within the specified temperature range and all humidity conditions which prevent condensation.

Operating and storage: 5 cycles (120 hours) at 90% relative humidity referenced to MIL-E-16400F Class III.

Altitude Operating: 3km (10,000 ft) without temperature derating

Non-Operating: 15km (50,000 ft)

Vibration Operating: 15 minutes along each of 3 axes at 0.25mm (0.01 in) double amplitude (p-p) displacement (4G limit) 10 to 2000 to 10c/s in 1 minute cycles.

Shock 20 g's, ½ sine, 11ms duration, 2 shocks per axis for a total of 6 shocks.

Transit Unit will meet National Safe Transit when factory packaged. Vibration for one hour at 1.2G 76cm (30 in) drops on corners, edges and flat surfaces.

DIMENSIONS

132 x 270 x 317mm (5¼" x 10¾" x 12½")

WEIGHT

5kg (11 lbs) approx.

ACCESSORIES SUPPLIED

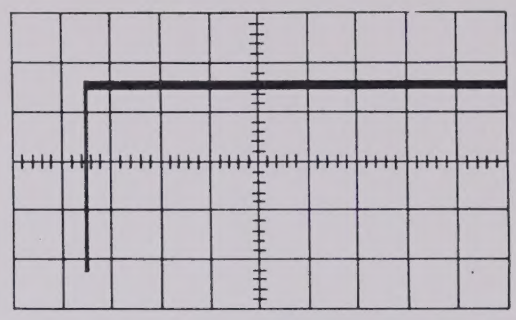
2 x PB13 Passive Probe Kits with X10 attenuation.
2 PL44 Input Leads.

OPTIONAL ACCESSORIES

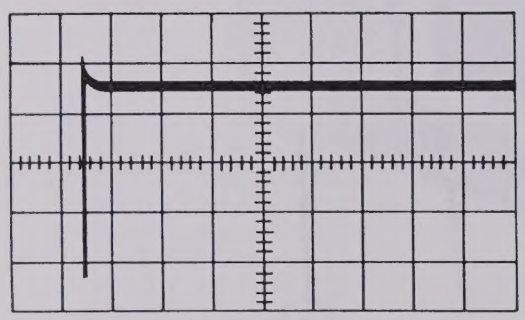
Probe Kit PB12. A passive probe kit with switched X1 and X10 attenuations. With X10 attenuation the input impedance is 10MΩ/13.5pF.

Carrying Bag PN35887

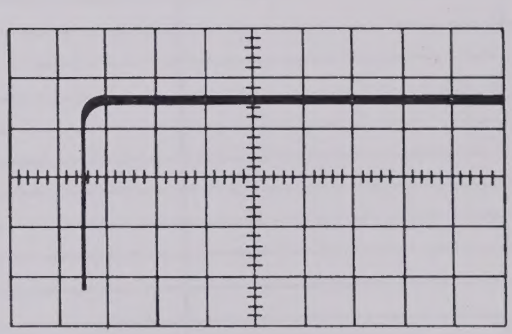
PROBE COMPENSATION (See Section 3.9c)
Using GATE O/P pin
X set to 1ms/div
Y set to 20mv/div



Proper Adjustment of Probe
Compensating Capacitor

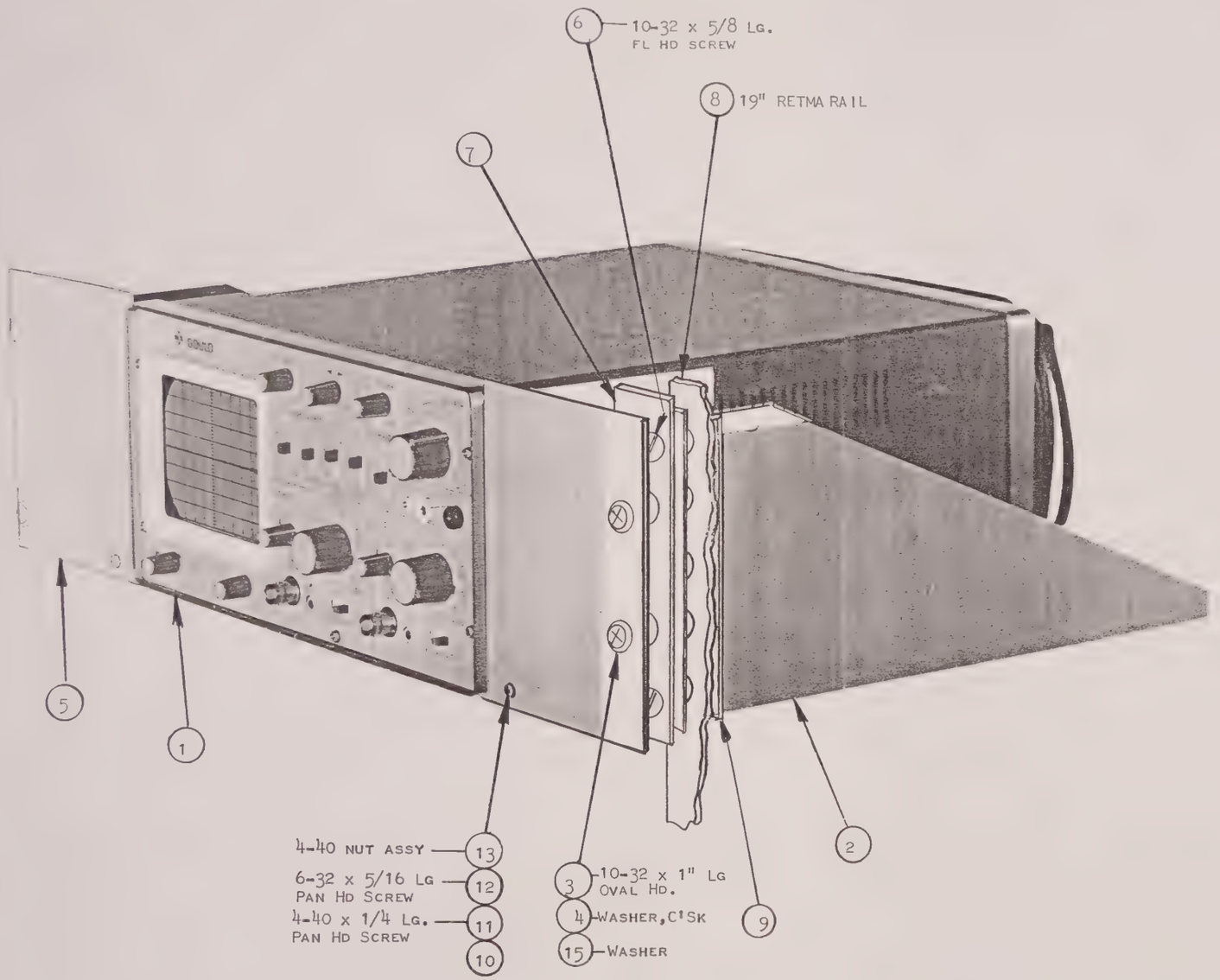


Over Compensated



Under Compensated

REVISIONS		
SYM	DESCRIPTION	DATE



NOTES:

1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. ASSEMBLE ITEMS 2,7 & 9 TO FRONT CABINET RAILS USING ITEM 6.
3. TO ASSEMBLE ITEM 1 TO ITEM 2, THE FOLLOWING PARTS MUST BE REMOVED. (4) PLASTIC FEET ATTACHED TO ITEM 1 AND (4) SCREWS SECURING BOTTOM COVER TO SCOPE. PLACE SCOPE WITH OR WITHOUT (OPTIONAL) BOTTOM COVER ONTO SHELF ITEM 2. AND FASTEN WITH PREVIOUSLY REMOVED SCREWS. (#4 X 1/4" LG.) PAN HEADS.
4. ASSEMBLE ITEM 5 TO FRONT CABINET RAIL USING ITEMS 3 & 4.

5. DRAWING ONLY.

ITEM	BRUSH PART NO.	DESCRIPTION	QUAN
30			
29			
28			
27			
26			
25			
24			
23			
22			
21			
20			
19			
18			
17			
5. 16	690981-2	KIT ASSY., RACK MTG	1
15	126138-5	WASHER, NYLON	4
14	222640	CARD, CONCEALED DAMAGE	1
13	243898-40	NUT ASSY.	2
12	31-119918-6205	SCREW, PAN HEAD	2
11	8-249616-4004	SCREW, PAN HEAD	2
10	269750	BRACKET, ANGLE	2
9	264959	NUT, PLATE	2
8	CABINET	19" RETMA	-
7	268886	SPACER	2
6	31-11920-0210	SCREW, FLAT HEAD	4
5	292082	PANEL, FILLER	2
4	31-120650-10	WASHER, COUNTERSUNK	4
3	31-121534-0216	SCREW, OVAL HEAD	4
2	492081	SHELF, RACK MTG.	1
1	690981-1	OSCILLOSCOPE	-
ITEM -2	BRUSH PART NO.	DESCRIPTION	QUAN
	SHIPPING LIST		

BY	DATE	NAME	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A.
DR. D. BAILEY	7/78	KIT ASSY., RACK MTG	
CH. Francis	7/78		
APP. Francis	7/78	CODE IDENT. 96795 / ISSUE CODE G	DWG. NO. 690981

Operation

Section 3

3.1 SWITCHING ON

CAUTION The OS245A employs convection cooling and must always be operated in a position such that external air circulation is not restricted.

1. Set the support/carrying handle to the required operating position. The handle is released by pulling both fixing bushes outward. It can then be turned to lock in one of 2 positions.
2. Check that the supply input selector switch is correctly set for the supply voltage. The switch is mounted within the instrument. Check that the fuse fitted is correct for the selected range (see rear panel detail). To change the setting and/or the fuse see section 5.1 b.
3. Turn INTENSITY control clockwise away from the OFF setting and ensure that the indicator lights up.

3.2 OBTAINING A TRACE

1. To obtain a trace
   (a) Set the CH1 shift control to approximately mid setting.
   (b) Set the CH2 shift control to CH2 OFF.
   (c) Set the X shift control to approximately mid setting.
   (d) Set BRIGHT LINE slide switch to ON.
   (e) Set the TIME/DIV switch to 10μs.
   (f) Adjust the INTENSITY control to obtain a display of the required brightness.
   (g) Centralise the display by adjusting the CH1 and X shift controls.
   (h) Adjust the FOCUS control to obtain a sharply defined trace.

3.3 SETTING UP THE Y CHANNELS

1. Using a coaxial input signal lead, connect a signal to the CH1 or CH2 input socket.
2. For
   (a) Direct connection of the input signal, set the associated AC-Ground-DC slide switch to DC.
   (b) Capacitive coupling of the input signal through an internal 0.1μF 400V capacitor, set the slide switch to AC.

NOTE When examining low amplitude a.c. signals superimposed on a high d.c. level, the slide switch should be set to AC and the sensitivity of the Y amplifier increased as in (4).

3. To locate the base line, set the slide switch to the GND setting. At this setting, the input signal is open circuit and the input to the amplifier is connected to ground.
4. To select the sensitivity, set the VOLTS/DIV switch to the required range. To minimise pick up at sensitive settings it is essential to ensure that the ground lead connection is near to the signal point.
5. For vertical shift of the trace, adjust the Y shift controls (identified by the vertical arrows).
6. Any trace movement under no signal conditions, when the setting of the VOLTS/DIV switch is altered, can be minimised by adjustment of the preset front panel balance control.

   This control will only need adjustment at infrequent intervals. Before adjusting the BAL control however, ensure that the input coupling switch is set to GND. In any case no adjustment should be made until a minimum of 15 min. warm-up time has elapsed after switch on, or immediately after any large change of ambient temperature.

3.4 SINGLE TRACE

For single trace operation on CH1, set
   (a) The CH1 shift control to the mid position.
   (b) The CH2 shift control to OFF.

3.5 DUAL TRACE OPERATION

For dual trace operation set both shift controls to the mid positions approximately.

In the dual trace condition, the beam switching function is in operation and results in display of the two signals simultaneously. Two modes of beam switching – chopped and alternate – are used, and selected automatically by the setting of the TIME/DIV switch. On any fast setting from 1μs/div to 0.5μs/div inclusive, the alternate switching mode is in operation. At slow settings from 1ms/div to 0.5s/div inclusive, the chopped mode is in operation.

3.6 TIMEBASE AND X EXPANSION

The sweep speed of the internal timebase (i.e. the time scale of the horizontal axis) is determined by the setting of the TIME/DIV switch. The setting of the switch automatically determines which mode of beam switching is used during dual trace operation. In addition to selection of the speed of the internal timebase, the switch has one further setting, X-Y, at which the internal timebase is inoperative.

1. To adjust the time scale of the horizontal axis:
   (a) Set the TIME/DIV switch to a suitable setting.
   (b) If necessary, the sweep may be slowed by the uncalibrated VARIABLE control.

NOTE The range of the variable control is approximately 2.5:1. Except at the CAL setting, the VARIABLE control is uncalibrated. At the CAL setting, the calibration corresponds to the setting of the TIME/DIV switch.

2. For horizontal shift of the trace, adjust the X shift control (identified by the horizontal arrow).
3. If close examination of any portion of the trace is required, two degrees of expansion are provided on the X EXPAND slide switch, namely x5 and x10, these provide respectively effective trace

lengths of 50div and 100div. Any portion of increased sweep length may be selected for viewing on the screen, by use of the X shift control.

3.7 X-Y MODE

When the TIME/DIV switch is set to X-Y, the CH1 is switched to the X amplifier. Under this condition, an external signal applied to the CH1(X) socket is routed through the input attenuators in CH1, and the full range of sensitivity may be utilised to obtain a calibrated horizontal deflection. Only single trace operation is possible. In this mode, the CH1 shift control is inoperative and X shift is effected by the X shift control. The X bandwidth is 500kHz and the relative phase shift between X and Y is significant only above 20kHz.

3.8 TRIGGER

The timebase may be triggered from the positive or negative slope of the signal selected by the TRIG SELECT switch as follows:

(a) CH1 or CH2 signal (irrespective of which beam is being displayed).

(b) An external triggering source connected to the EXT TRIG socket.

When the BRIGHT-LINE slide switch is set to OFF, the timebase will only trigger when the trigger signal reaches the selected level. When the level control is set outside the range of signal or when there is insufficient signal amplitude the timebase will not run and the screen will remain blank.

The normal mode of operation is with the BRIGHT-LINE ON, when the timebase will free-run in the absence of the correct trigger signal to display a bright line or unsynchronised display until the level control is adjusted and/or the amplitude of the trigger signal is increased. This free-run action in the absence of correct trigger helps in finding the trace and leads to ease of operation. If the timebase is required to free-run continuously, the LEVEL control should be set to either end of its rotation.

It is expected that the BRIGHT-LINE OFF mode will be selected only when the instrument is to be used to display signals at repetition rates below 45Hz to prevent additional sweeps between correctly triggered sweeps.

The TRIGGER SELECT switch is used in conjunction with the AC-ACF-TVF slide switch. This latter switch connects different networks into the trigger amplifier circuit and is effective at all settings of the TRIGGER SELECT switch. The operating facilities available at the three settings of the slide switch are as follows:

AC – Wide band trigger mode used for most signals.

ACF A filter is switched into circuit to reject low frequencies. High frequency triggering may be effected from complex waveforms such as those with high ripple content or line triggering from a television video signal waveform. The filter cut-off frequency is approximately 20kHz.

TVF – A filter is switched into circuit to reject high frequencies. Its cut-off is chosen to accept the frame synch of a TV video waveform and reject the line frequency component. The filter cut-off frequency is approx 200Hz.

Summarising, trigger control is effected as follows:

1. Set the TRIGGER SELECT switch to select the required trigger signal and slope.
2. Set the AC-ACF-TVF switch to the required setting.
3. Adjust the LEVEL control so that the trace starts at the required point on the waveform.

3.9 ADDITIONAL FEATURES

(a) Gate Output

This output pin provides a positive-going square wave of approximately 1V ± 3% amplitude from a source impedance of 750Ω. Its frequency is dependant on the setting of the TIME/DIV and is suitable for probe compensation. (See section 3.9.c.)

(b) Z Mod

The socket on the rear panel allows an a.c. coupled signal to modulate the brightness. The input impedance at this socket is 100kΩ; the frequency response, 2Hz – 10MHz; and the sensitivity, approximately 10V p.t.p. for visible modulation at normal brightness, and approximately 60V for full blanking, a positive going signal increasing brightness.

(c) Use of Optional Passive Probe

Passive probes may be used to extend the voltage range and increase the input impedance of the Y amplifiers. The input resistance of a Y channel is 1MΩ shunted by approximately 28pF. The effective capacity of the input lead must be added to this and the resultant impedance can often load the signal source. Therefore it is advisable to use a 10MΩ X10 probe e.g. the Gould PB12. This reduces the input capacity and increases the input resistance, at the expense of a 10:1 reduction in sensitivity. The probe contains a shunt RC network in series with the input and forms an attenuator with the input RC of the Y channel. To obtain a flat frequency response it is necessary to adjust the capacitance of the probe to match the input capacity of the Y channel as follows:

1. Set the channel VOLTS/DIV switch to 20mV/div, the TIME/DIV switch to 1ms and TRIG INT POS from the appropriate channel. Set probe to X10.
2. Connect the probe to the GATE O/P pin.
3. Adjust the probe compensation to obtain a level trace, i.e. flat top without overshoot or undershoot over the first few milliseconds of the trace.

Circuit Description

Section 4

The OS245A block diagram is shown in Fig.1. Interconnection of the printed circuit boards, controls,tube and associated components is shown in Fig.5.
Circuit diagrams are as follows:

Fig.2 CH1 and CH2 attenuators, pre-amplifiers, the main Y amplifier, beam switch and drive circuits.
Fig.3 Timebase, X amplifier and trigger circuits.
Fig.4 The power supply, bright-up and tube network.

4.1 GENERAL

Referring to the block diagram (Fig.1) signals applied to the CH1 and CH2 input sockets pass into their respective attenuators and amplifiers. The VOLTS/DIV switch controls the gain of the amplifier in a 1.2.5 sequence to cover the ranges from 5mV/div to 0.2V/div. Above this a ÷ 100 attenuator is introduced before the amplifier.

The fast electronic beam switch selects either the CH1 or the CH2 signal to be amplified further and passed to the Y deflection plates of the c.r.t.

A sample of each signal is taken and passed to the trigger switch, where selection of CH1, CH2 or Ext. trigger source is made. The selected trigger signal is amplified and passed to the Schmitt trigger, where it is converted into fast negative pulses. The hold-off circuit acts as a gate which is normally open to allow a trigger pulse to set the timebase bistable. The bootstrap ramp generator then begins to generate its linear ramp, which after passing through the X amplifier is applied to the cathode ray tube and drives the electron beam linearly across the screen.
A small portion of the signal from the ramp generator is fed back to the hold-off circuit, shutting the gate to prevent any further pulses from the Schmitt trigger from reaching the timebase bistable during the ramp period. When the ramp has reached the necessary maximum level, the timebase bistable is reset, and the ramp is quickly returned to its quiescent state. A time constant in the hold-off circuit now holds the gate closed to inhibit another ramp from being initiated for a short period, until the ramp timing capacitor is fully discharged. Thus a ramp is generated at a rate set by the TIME/DIV switch when the trigger signal reaches a predetermined level. This ramp sweeps the beam across the c.r.t. face, returns and waits for the next trigger point to be reach. The timebase bistable is connected to a bright-up amplifier whose function is to turn on the electron beam during the sweep and blank it off during the flyback and subsequent waiting period.

At fast sweep rates, for a dual trace display, the TIME/DIV switch automatically selects the alternate sweep mode of control for the beam switch. At the end of each sweep the signal from the timebase bistable reverses the

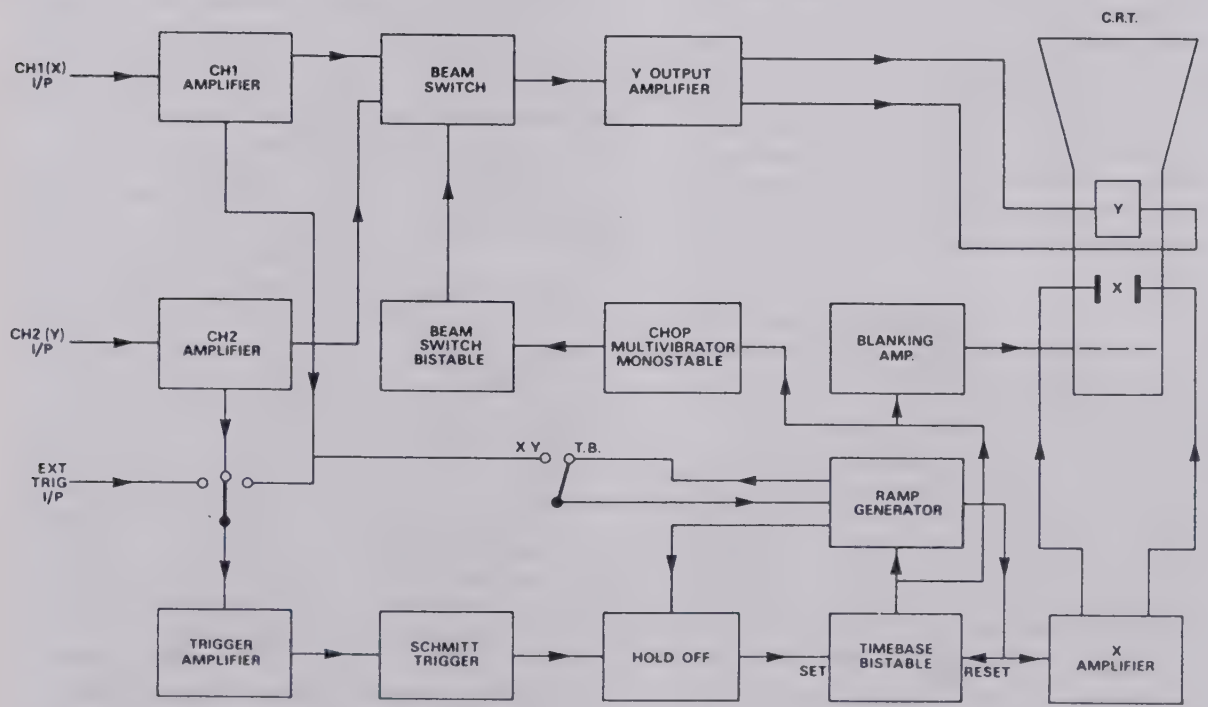


Fig. 1 Block diagram

state of the beam switch bistable, causing alternate displays of the CH1 and CH2 signal on successive sweeps of the timebase. At low sweep rates, the chop mode is selected, when the chop oscillator free runs independently, causing the beam to switch CH1 and CH2 levels during the sweep. A signal from the oscillator also blanks the trace during each switching transition. With the CH2 switched to the OFF position, the beam switch is locked to switch on CH1.

In the X-Y mode, the signal from the CH1 amplifier, normally used for trigger, is passed via the ramp generator, which acts as a voltage follower, to drive the X plates while the beam switch selects CH2 to drive the Y plates. The beam blanking signal is not used.

4.2 THE Y AMPLIFIERS

The attenuator and the pre-amplifier in the CH1 are identical to those in the CH2. Accordingly, only the CH1 is described.

The input is applied to the front panel socket, SKC, and then to the 3 position slide switch, S20, via R20. The switch selects a.c. or d.c. input coupling by including or by-passing C21 in the signal path. In the middle position of the switch, the input socket is disconnected and the input of the attenuator is connected to ground through the network, C240 and R294. The attenuator feeds into an impedance of 1MΩ, R202. The ÷100 attenuation is determined by the potential divider action of R26 in series with the parallel combination of R201 and R202. High frequency compensation of the attenuator is achieved by the a.c. potential divider, C202 and C204; C202 is set for the correct ratio. C201 is adjusted to maintain constant input capacitance between attenuated and unattenuated ranges. This attenuator is used on the six higher voltage ranges, i.e. 0.5V/div to 20V/div, dividing them down to 5-200mV/div. Further selection of input sensitivity is carried out by gain switching within the amplifier and is described later.

Diodes, D203 and D204, in conjunction with R203 protect the input up to 400 volts peak.

The input stage of the amplifier consists of a matched pair of field effect transistors TR201 and TR202. The input signal is applied to the gate of TR201 and the d.c. balance signal to TR202 via the potential divider R217/ R213.

The following stage incorporates the gain switching arrangements and is formed by the emitter follower TR203 and the common base stage TR204. Gain switching is achieved by variation of the resistance between their emitters. Signal current from the collector of the common base stage TR204 passes to the shunt feedback amplifier TR205.

Minimum change of balance during warm-up and with ambient temperature changes is achieved by the use of the dual matched F.E.T. operating at low current in the first stage and by thermally coupling transistors TR203 and TR204. Adjust on test resistors R401 and R402 in conjunction with R264 provide for centering of the shift control range.

The signal from the collector of TR204 is passed via R220 to the base of TR205 which, in conjunction with TR206, forms a long tail pair amplifier, the gain of which is set by R223 and R229.

The collector current of TR205 feeds into the trigger section of the timebase and X amplifier circuit (Fig.3). Potentiometer, R30' provides a variable current via R225 into the collector circuit of TR206, to produce a Y shift. The bases of TR206 (CH1) and TR216 (CH2) are driven from the collector circuit of TR217 which being connected in a manner similar to TR204 and TR215, provides the correct bias and compensation for supply and temperature variations.

The beam switch consists of diodes, D207, D208, D209, and D211, with their associated drive circuitry and is described in detail in section 4.3. It selects the collector current of TR206 or of TR217 to pass through D210 and R229. The voltage developed across R229 consists of a fixed d.c. component, a variable d.c. component (Y shift) and the signal, and is applied to the base of TR207, a common emitter amplifier. The emitter circuit includes potentiometer, R233, to set the gain of the stage and hence the overall gain of the amplifier. The signal from the collector of TR207 is passed to the base of TR208, which with TR209, TR210 and TR211, forms the output cascode stage. TR208 and TR209, is a long-tail pair, which converts the input signal voltage to differential output current; its gain is determined by the emitter resistor, R234, with high frequency gain set by networks, R241/C217 and R240/C216. The collector currents of TR208 and TR209 flow into the emitters of the grounded base transistors, TR210 and TR211, to develop the differential output voltage across the load resistors, R236/ R244, to drive the c.r.t. deflection plates. Inductors, L201 and L202, are included to improve the high frequency response.

4.3 THE BEAM SWITCH

The beam switching waveforms are generated by IC201, a dual J-K flip flop within a single 16 lead package, one section operating as the chop oscillator the other as the beam switch bistable. The flip-flop is made to oscillate by taking signals from the Q2 and $\overline{Q2}$ outputs and feeding them back to the clock input via the amplifier transistor, TR219. The oscillator section is not, in fact, self starting and must be triggered into operation, this is achieved by feeding the alternate pulse to the clock input via TR220. This is not a disadvantage since the alternate pulse is always present under normal conditions when the timebase is running.

The frequency of operation and the mark-space ratio of the output is determined by the time constants, C234/ R284 and C233/R283. An output is taken from Q2 to drive the second flip-flop.

The cathode of D207 is supplied with a 5 volt positive-

going square wave from Q1. When the waveform is 'high', D207 is biased off and the collector current of TR206 passes through D208 and D210 into the output amplifier. During the 'low' state of the waveform, D207 conducts, passing this current to ground through the output of the flip-flop Q1. As diodes, D207 and D211, are fed with complementary waveforms when the current from TR206 passes to the output amplifier, that from TR217 is shunted to ground and vice-versa.

The chop oscillator section runs at approximately 500kHz on TIME/DIV settings from 0.1 sec to 1 ms causing the beam switch to operate at 250kHz. A further output is taken from $\overline{Q}2$ and fed to the bright-up amplifier circuits, this in turn is fed to the c.r.t. to blank the traces during the beam switching transitions.

In the chop mode of operation alternate pulses from the timebase bistable are fed to a "J" input of IC201. This has the effect of inhibiting the beam switching operation during the flyback and hold-off periods, thus preventing switching spikes interfering with the trigger circuits.

At faster TIME/DIV settings of 0.1 ms to 1 μs, the positive end of D216 is returned to the +20V line via R287 and a contact on the timebase switch. This potential turns off D216, preventing the feedback action and stopping the chop oscillator. This flip-flop is now clocked via TR220 at the end of each sweep by pulse from the timebase bistable, each pulse reversing the beam switch bistable for alternate display of CH1 and CH2.

For single trace operation, the CH2 shift control is rotated fully anti-clockwise to operate the OFF switch. In this position the switch, S27, is closed grounding Preset (Q1). This causes $\overline{Q}1$ to go 'low' shunting the collector current of TR217 to ground. Q1 goes 'high' turning off D207 and directing collector current from TR206 to the output stage. Thus only CH1 trace is visible on the screen. Switch, S27, also grounds Preset (Q2) which stops the chop oscillator when operating in the single trace mode.

In the X-Y mode, CH2 shift control is set in the ON position. Clear (Q1) is grounded via D12 on the timebase switch. This causes Q1 to go 'low' shunting the collector current of TR206 to ground and allowing CH2 signals only to reach the Y output stage.

4.4 THE TRIGGER CIRCUITS

The collector currents from TR205 and TR216 in the Y amplifier, pass to the timebase printed circuit board into R108 and R109, respectively. In series with R108 is R110 shunted by C101, a collector load netowrk used when X-Y mode is selected. External trigger signals appear across R107 and these, together with those across R108 and R109, pass to the trigger selector switch. The selected trigger signal is amplified by TR107 and passed to the coupling switch. Here, direct, high pass and low pass filter networks provide the required AC-ACF-TVF response. Trigger level and slope selection operations are performed by the long-tail amplifier, TR101/TR102. The signal is applied to either input as determined by the slope selector switch, the other input being grounded via C121. The trigger level control, R187, provides a variable d.c. bias at both inputs, which the amplifier sums with the signal. The output at the collector of TR102, consisting of an alternating signal voltage superimposed on a d.c. level, passes to the Schmitt Trigger, TR103/TR104, where fast negative edges are generated as the input signal crosses the circuit threshold.

4.5 BRIGHT LINE CIRCUIT

When sufficient trigger signal is available, the square wave from the collector of TR104 passes through R127/C104, where restoration by D101 produces a negative going signal with respect to the negative rail. This negative signal on the base of TR105 is integrated by R124/C107 to produce a d.c. bias sufficient to hold off TR106. In this condition the circuit has no effect on timebase operation. However, when the triggering signal falls below the required level, the Schmitt trigger ceases to operate, removing the signal from D101. The voltage on the emitter of TR105 rises to approximately one volt above the negative line, turning on TR106. R177 is now effectively connected between the negative rail and the cathode of D102. It rapidly discharges the hold off capacitor below the normal quiescent level to a point where D102 conducts, turning TR108 off and initiating a sweep. At the end of the ramp, the charge on the hold off capacitor is again removed by R177/R143 and another ramp begins. These consecutive sweeps produce the bright line display. When the "BRIGHT LINE OFF" control is operated, switch S12 closes, effectively shorting the base and emitter of TR106, holding it off; in this condition a ramp is only generated after the arrival of a trigger pulse.

4.6 THE TIMEBASE BISTABLE AND RAMP GENERATOR

The ramp generator comprises TR111, TR112 and TR113 as cascaded emitter follower stages, with bootstrap feedback action provided from the cathode of zener diode, D104. This feedback maintains constant voltage across the VARIABLE TIME control, R185, R148, R147 and the variable timing resistor selected by the TIME/DIV switch. This constant voltage drop, independent of actual voltage level, produces a constant current to linearly charge the timing capacitor, also selected by the TIME/DIV switch. The VARIABLE TIME control provides fine adjustment of the timing current, and hence sweep time, by varying the feedback voltage applied to the timing resistor.

In the quiescent condition of the timebase bistable, TR108 is on, TR109 is off and clamp transistor, TR110, which shunt the timing capacitor, is saturated. A negative-going pulse from the Schmitt Trigger is coupled via C111 and D102 to turn off TR108. TR109 turns on, thus turning off TR110. The clamp is removed, allowing the timing capacitor to charge, producing the linear ramp. As the emitter of TR113 rises, a feedback voltage, via D105, R143 and R133, biases off D102 to prevent any

further pulses reaching the bistable. Connected to the junction of R133/R143 is the HOLD-OFF capacitor which now charges positive. When the ramp reaches its final amplitude, a rise of approximately 10V, feedback from the junction of R151/R149 is applied to the base of TR108 turning it on. The bistable now reverts to its initial state allowing TR110 to turn on, rapidly discharging the timing capacitor and returning the ramp to its quiescent level. The hold-off capacitor, which was charged to a positive voltage during the ramp, now slowly discharges through R143 and R153, until it is caught by D105. Only then is D102 biased for the next trigger pulse to initiate the next sweep.

The output is taken from the ramp generator via R155 to the input of the X output amplifier.

4.7 THE BRIGHT-UP CIRCUIT and TUBE SUPPLIES

The bright-up circuit consists of TR311, TR312 and TR313 arranged in the form of a bistable. The bistable is clocked on or off by the AC coupled signal via C310 and C311 to follow the collector signal of transistor TR309. The output from the bistable at the junction of the collectors of TR311 and TR312 is taken to the cathode of the CRT.

When operating in the chop mode, pulses from the chop oscillator are fed to the base of TR309 via TR308. Short positive-going pulses at the base of TR309 during the sweep cause the tube beam current to be cut off for the period of the chop transition.

The focus chain is supplied from the −1500V line via two zener diode networks; D315 and D316 provide a 60V supply across which is connected the intensity control, R342 and D317, which provides a 30V supply for the bright-up amplifier.

The low potential end of the focus chain is returned to the e.h.t. stabiliser circuit described in a leter section.

Geometry and Astigmatism adjustment are provided by R315 and R345 in series with R359 and R360 connected across the 280V line.

Z Modulation signals may be applied via the socket on the rear panel and C314 to the grid of the c.r.t. where they produce intensity modulation.

4.8 THE X OUTPUT AMPLIFIER

The ramp or X-Y signal at the emitter of TR113, passes through R156 to the base of TR114 which with TR117 forms a long tail pair. Gain switching is carried out in the emitter circuit by selection of one of three resistance paths, with gains set by R169/R189(X1), R162/R188(X5) and R158(X10). In the timebase mode, the X EXP.switch, S15, can be operated in order to expand the trace length 5 or 10 times. In the X-Y mode contacts on the TIME/DIV switch, is parallel with S15 close to select a X10 gain setting automatically. An X shift voltage is produced at the base of TR117 by R186. The signals on the collectors of TR111 and TR117 are applied to the differential output amplifiers, TR115 and TR116. Signals from the collectors of these two transistors drive the horizontal deflection plates of the c.r.t.

4.9 X-Y MODE

In this mode, signals are applied to both CH1 and CH2 input sockets; CH2 is routed through the beam switch to the Y deflection plates in the normal manner. CH1 is routed through the ramp generator, now acting as a high impedance unity gain buffer, and into the X output stage.

Signals entering the CH1 channel pass through the attenuator and gain switching stage, as previously described. Current from TR205 passes to the X board, while that in TR206 is shunted to ground through D207. The current from TR205 develops a voltage across the series connections of R110, R108. This voltage is level shifted by R144/R146 to the base of TR111. In the X-Y mode, both timing resistors and capacitors are switched out of circuit, consequently TR111, TR112 and TR113 merely act as emitter followers which provide buffering between the level-shift resistors and the X amplifier.

When this mode is selected, a contact on the TIME/DIV switch, S14(a), connects a 'clear' input in the beam switch J-K flip-flop, to ground; this has the effect of taking Q1 'low' shunting CH1 signals to ground via D207. Q1 goes 'high' thus turning off D211 and allowing CH2 signals to pass to the Y output amplifier via D209.

Also when this mode is selected, S14 connects the cathodes of D106 and D107 to the negative line. The current drawn through D106 and R138 turns of TR108 and consequently TR110, and removes the blanking. It also connects +20V to D216 via R287 turning off this diode and stopping the chop oscillator.

4.10 POWER SUPPLIES

All power supplies are derived from transformer, T31. The primary windings are connected to a slider switch arranged to accept three supply voltage ranges.

The transformer secondary has four windings developing the following r.m.s. voltages: 6.3V, 44V (centre tapped), 115V and 1250V.

The 6.3V winding supplies the c.r.t. heater.

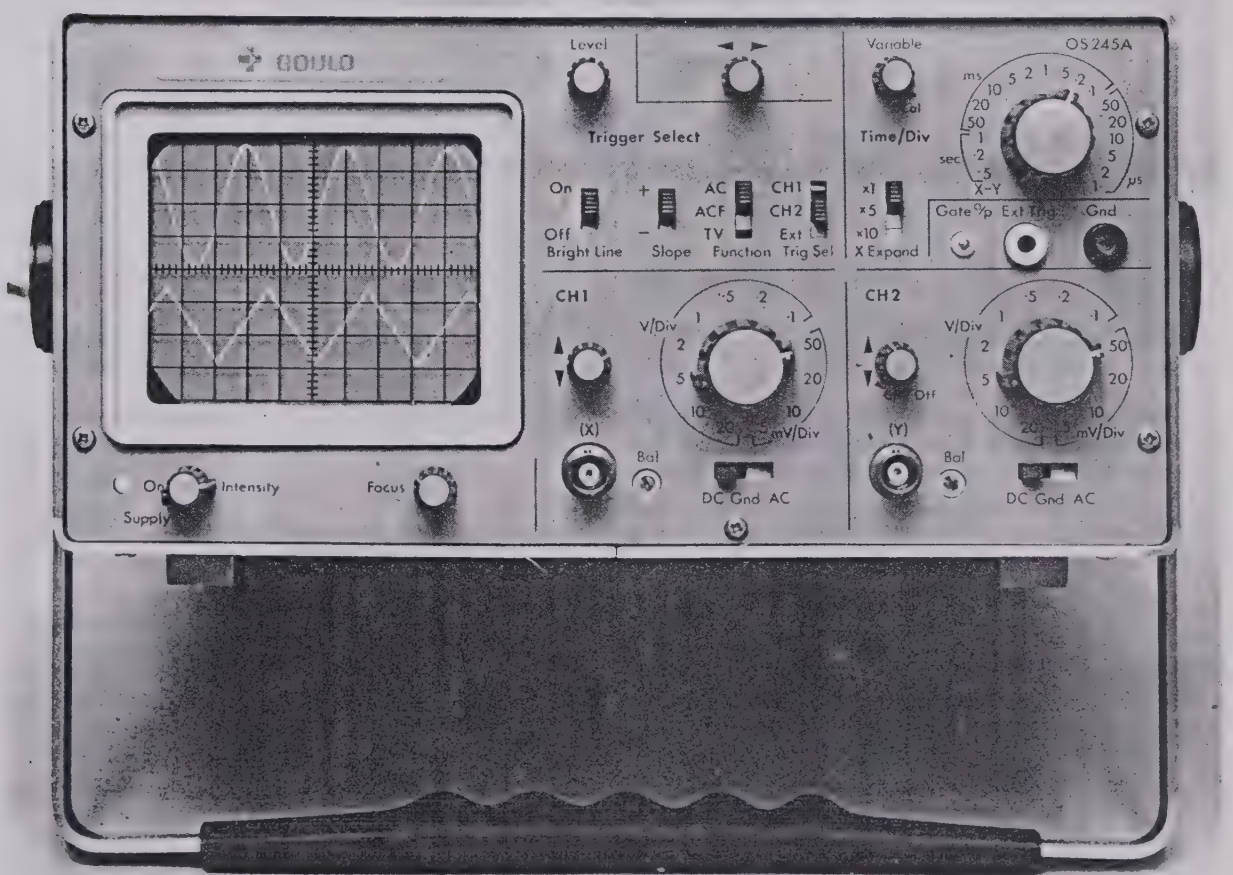
The 44V a.c. is rectified by MR301 and smoothed by C301/303 to form the unstabilised +26V and −26V d.c. lines. These voltages are fed to series regulators to provide the stabilised +20V and −20V lines. As both regulators operate in an identical manner, only one will be described.

The base of the series pass transistor, TR313, is fed from the output of the high gain error amplifier formed by TR301 and TR302. This amplifier compares the zener reference voltage from D307 with the voltage at the junction of R306 and R309, a potential divider connected between the emitter of TR313 and ground. As this emitter supplies the +20V line, any fluctuations in the line voltage appear at the base of TR302, where they are amplified inverted. This signal is then fed to the base of TR313 to correct the error, thus maintaining a constant output voltage. Resistor, R305, in series with the collec-

tor of TR313 drops a voltage which is proportional to the output current. Under normal conditions, this voltage drop is less than that across R303, biasing off D309. As the output current rises above the safe manimum, D309 turns on, taking the current in R303 away from the emitter of TR301. This causes a drop in the voltage at the collector of TR302 and hence on the base and emitter of TR313, limiting the current to a safe value.

The voltage from the 115V is rectified by D302 and D301 in half wave and voltage double circuits to provide outputs of 140V d.c. and 280V d.c., both unstabilised.

The −1500V line is derived from the 1250V winding via the diode, D311, and smoothing circuit, C307/C308 and R313. Stabilisation of this line is achieved as follows. The positive end of the supply is returned to ground via the collector of TR306 which under nominal input voltage conditions is adjusted to approximately +200V. A current from the −1500V line is fed via the focus chain to the base of TR307, this current is balanced by a reference current from the +20V line via R351 and the e.h.t. potentiometer, R316. The voltage at the summing point of the two currents appears at the emitter of TR307 and controls the current in TR306. If the −1500V line drops in voltage for any reason, the voltage at the base of TR307 rises, consequently, so does the emitter voltage thus increasing the current in TR306 and causing a drop in its collector voltage. Since this collector potential is effectively in series with the −1500V supply the drop will compensate for the fall in the −1500V line. A rise in the −1500V will be similarly compensated for by a rise in the collector potential of TR306. An additional degree of compensation is achieved by adding a further current at the summing point from the −27V line via R312.



5.1 GENERAL

Figs.6 and 7 show the internal location of sub assemblies and preset controls. Access to all preset controls and most other components is obtained by removing the top and bottom covers. The construction of the instrument is such that full access to most components can be achieved without removing the sub assemblies from the main frame. Should this be necessary however, the procedure outlined in Section 5.2 should be followed.

(a) Removal of covers

The instrument covers consist of a 'wrap round' cover for the top and sides and a single plate for the bottom. Both covers are retained in position by the same four screws, removal of which frees the bottom cover and allows the top cover to be 'sprung' out and lifted away from the frame of the instrument.

(b) Supply Voltage Adjustment and Fuse Replacement

DISCONNECT THE INSTRUMENT FROM THE SUPPLY BEFORE REMOVING COVERS.

Both the supply voltage adjustment and the fuse are accessible by removal of the bottom cover of the instrument. The supply voltage adjustment is by means of a slide switch mounted on the power supply printed circuit board, the voltage ranges being marked on the board alongside the switch. The fuse holder is also mounted on the power supply printed circuit board close to the main tap switch, for 198-264V operation, a 20mm, 250mA slow blow fuse, Gould Part No.33684 is required. For 90-237V operation, a 20mm, 500mA slow blow fuse, Gould Part No.33685 is required.

5.2 REMOVAL OF SUB-ASSEMBLIES

Removal of the covers provides access to all preset controls and most other components for servicing purposes. For detailed repair, the instrument can be stripped down as follows:

(a) Y Amplifier Sub-assembly and Timebase Sub-assembly

1. Remove all knobs from Y amplifier, Timebase and c.r.t. controls.
2. Remove screws securing outer front panel and remove panel.
3. Uncouple all individual plug and socket leads on the assembly which it is required to remove.
4. Remove the single screw holding the assembly into the frame, the assembly may now be carefully pulled forward and removed from the frame.
5. When re-assembling the unit care should be taken to correctly locate the printed circuit board in its socket before pushing it home.

(v) Power Supply Assembly

It should not be necessary to remove this assembly as complete accessibility to all components is provided by the removal of either or both of the above assemblies as described.

(c) C.R.T. Replacement

1. Remove all knobs and the front panel as described in 5.2(a) above.
2. Remove the tube base connector.
3. Unsolder the leads to the neon indicator.
4. The c.r.t. and mu-metal screen assembly can now be removed through the front of the instrument.
5. Remove the four springs securing the mu-metal shield to the escutcheon.
6. The tube can now be removed from the screen.
7. Before inserting a replacement tube into the screen ensure that the foam rubber pads are correctly positioned.
8. Before finally replacing the instrument covers, switch on and check that the trace is parallel with the graticule lines. If this is not so, the tube should be carefully rotated in the shield to achieve the necessary correction.

5.3 FAULT FINDING

Before any fault location is attempted, it is suggested that all supply voltages are checked with respect to 0V. These are given in Table 1.

Table 1

LINE	MEASURED VOLTAGE	LOCATION
+20V	+19 to +21V	Emitter of TR313
−20V	−19 to −21V	Emitter of TR314
+140V	+130 to +150V	Pin marked "0V (115V)"
+280V	+260 to +300V	Junct.of D301/C304
−1500V	−1460 to −1540V	Junct.of R313/C308

NOTE: The power supply input voltage should be approximately at the centre of the range for which the mains tap switch is set.

Table 2, indicating voltages at various circuit locations, may be used as a general guide and servicing aid. The front panel controls should be set as follows:

INTENSITY, X SHIFT, CH2 SHIFT – all at mid position.
CH1 SHIFT – to CH1 OFF position.
CH1 and CH2 INPUT switches – to ground position.
TRIG SELECT – to CH1 +ve.
AC, ACF, TVF – to AC.
LEVEL – to mid position.
BRIGHT LINE – on.
TIME/DIV – to X-Y.

Adjust X and CH2 shift controls to bring the spot to the centre of the screen. If a fault on a printed circuit board cannot be cleared, it is recommended that the instrument be returned to the manufacturer for repair (See section 7). When faults have been cleared, it is recommended that the setting up procedure is followed. Calibration adjustments should be made only after a 15 minute warm up period.

Table 2

LOCATION	TYPICAL VOLTAGE
Y Amplifier Sub-assembly	
Base TR203, TR204, TR223, TR224	+1.1V
Collector TR204, TR224	3.9V
Collector TR205	+3.6V
Collector TR216	+3V
Collector TR207	+9.3V
Collector TR210, TR211	+110V
X Amplifier and Timebase Sub-assembly	
Collector TR107	+4V
Collector TR102	+13V
Collector TR106	−20V
Collector TR109	+0.1V
Emitter TR113	+5.5V
Emitter TR115, TR116	−6.8V
Collectors TR115, TR116	+120V
Power Supply Sub-assembly	
Collector TR306	+205V

5.4 SETTING UP PROCEDURE

(a) Test Equipment

1. Multirange Test Meter 0-2.5kV with sensitivity 20kΩ/V.
2. Variable Autotransformer, output voltage 100-270V at 1A.
3. Sine/Square wave signal generator covering the range 10Hz-100kHz, amplitude 20mV-5V.
4. Source of voltage and time calibration signals.
5. A.T.V. video wave-form generator.
6. Square-wave Generator. 500kHz flat top square wave generator with adjustable amplitude 0.2V to 1V into 50Ω, having a rise time of less than 5ns.
7. R.F. Sinewave Generator. 500kHz to greater than 10MHz with 50kHz reference frequency. Output amplitude 25mV to 5V pk to pk into 50 ohms, 10V unterminated. Amplitude accuracy at 50kHz and 500kHz to 10MHz within 3%.
8. 50 ohms B.N.C. termination.

(b) Power Supply Voltage

With the mains tap switch set for 115V operation, connect the instrument to the a.c. supply via a variable autotransformer, and set the voltage to 115V 1%. Check that the low voltage supply lines measured between the point indicated on the power supply printed circuit board and chassis lie within the limits quoted in Table 1.

Adjust R316 (e.h.t.) to give 205V between ground and the collector of TR306. Measure the voltage between the junction of R313 and C308 and ground which should be between 1460V and 1540V. This voltage should not change by more than ± 8V when the supply voltage is varied over the range 104V – 126V.

(c) Astigmatism

Set the front panel controls as follows:
TIME/DIV switch to X-Y, INTENS. to mid position, X shift to mid position, CH1 and CH2 shifts to mid position and CH1 and CH2 VOLTS/DIV switch to 2. Adjust X and CH2 shift to centre a spot on the screen. Adjust R315 (Astig) together with INTENS. and FOCUS controls to obtain a sharp round spot.

(d) DC Balance

Set the CH1 and CH2 input switches to ground. Adjust the CH1 and CH2 balance controls (R206 and R256 respectively) to eliminate Y trace shift when CH1 and CH2 VOLTS/DIV switches are moved from 0.2V/div to 0.5V/div.

(e) Timebase Calibration

Set the TIME/DIV switch to 1ms, the variable time to CAL, and X EXPAND to X1. Apply 1ms markers to the CH1 input, adjusting the attenuator to give approximately 2div amplitude and triggering without bright line. Adjust R165 for 1 pulse/div. Set TIME/DIV to 1μs, change markers to 1μs and adjust C10 for 1 pulse/div. Check the timebase accuracy on all ranges to specification. Check that the variable time control reduces the speed by greater than 2.5:1. Ensure that the trace length is greater than 10div on all ranges.

(f) Y Amplifier Calibration

Set both CH1 and CH2 attenuators to .2V/div, both input switches to DC, and the TIME/DIV switch to 1ms. Apply 1V from the calibrator to CH1 and adjust R233 (Y Gain) for a 5cm display. Apply the same signal to the CH2 input, trigger on CH2 and observe the deflection. Re-adjust R233 to equalise the errors from the 5cm deflection between CH1 and CH2.

(g) Input Capacity and Attenuator Compensation

Capacitors, C23 and C24, are selected such that the input capacitance is approximately 28pF.

To set the attenuator compensation, set the CH1 VOLTS/DIV switch to 0.5, the input coupling to DC and the TIME/DIV switch to 1ms. Connect a low impedance 3V, 1kHz square wave signal to the input and adjust C202 for a square top to the display. Repeat for CH2, adjusting C222.

To equalise the input capacitance on all ranges, set the CH1 VOLTS/DIV switch to 0.2, the input coupling to DC.

Connect a 1kHz square wave signal either via a 10:1 probe or a 1MΩ series resistor connected in parallel with a 10-40pF trimmer capacitor, mounted close to the input socket. Set the input amplitude for approximately 6cm of display and adjust the probe compensation or the trimmer for a square top to the display. Set the CH1 VOLTS/DIV switch to 0.5 and adjust C201 to regain the flat top to the display.
Repeat for CH2 adjusting C221.

(h) Trigger Sensitivity
Switch CH1 attenuator to 1V/div, trigger selector to CH1, AC. Inject into CH1 channel 0.3V from the calibrator. With BRIGHT LINE off check that rotation of the level control gives a stable display of the correct slope in both +ve and −ve positions. Check that the timebase does not free run at any setting of the level control. Switch to BRIGHT LINE on, check that rotation of the level control gives a stable display of the correct slope in both +ve and −ve positions bur free-runs outside this range. Remove the calibrator from the CH1 input and set this input to ground. Check that the time-base free-runs at all settings of the level control in both +ve and −ve positions. Repeat for CH2 channel.

(i) ACF and TV Trigger
Set the CH2 attenuator to 1V/cm and select ACF. Inject 1V into CH2 channel from the calibrator. Two stable trigger points of opposite slope should be found in the level control. Switch to TV, CH2 and apply to CH2 input a video waveform from a video waveform generator. Adjust the CH2 attenuator to give 1-2div display. Adjustment of the trigger level control should give a stable display triggered from a video frame pulse. Remove the video input and return the trigger switch to AC.

(j) EXT Trigger
Switch the CH2 attenuator to 5V/div and trigger selector to EXT. Inject a 1V square wave from the calibrator into the CH2 input and into the EXT trigger socket. Check that the display triggers +ve and −ve and in both BRIGHT LINE 'ON' and 'OFF' modes.

(k) Pulse Response
Switch the CH1 attenuator to 20mV/div and set the TIME/DIV to 1μs. Apply a 500kHz signal from the SG21 to the CH1 input using a 50 ohm termination. Adjust the output from the generator to give a 5div display.

Check the top of the pulse for flatness and adjust trimmer C218 as necessary. Adjust C215 and AOT C218 for a square corner and optimum rise time without a step in the leading edge.

Apply the signal generator to the CH2 input and adjust AOT C223 to give a good square wave response on CH2 channel.

It is important not to improve the risetime performance by adjustment of C215 and C218/C223 such that the bandwidth exceeds 14MHz. Bandwidth in excess of this will cause pulse response variations with shift control adjustment.

Check that the pulse response is square on all ranges between 5mV/div and 0.2V/div, adjusting the generator output for 5div on each range, on both CH1 and CH2, allowing a maximum of 4% overshoot or undershoot.

(l) Bandwidth
Set the CH1 attenuator to 5mV/div and apply the constant amplitude generator to the CH1 input. Set the frequency to 50kHz and adjust the generator output to give a 5div display. Increase the frequency until the amplitude falls to 3.5div (−3dB). This frequency should be between 11 and 14MHz.
Repeat for the CH2 channel.

(m) HF Trigger
With the constant amplitude generator applied to the CH2 input and the TIME/DIV set to 1μs, and X EXP to X5, set the generator to 10MHz and adjust the output to give 1div display. It should be possible to obtain a clearly triggered waveform by adjustment of the trigger level control. Repeat for CH1 channel.

(n) X−Y Operation
Switch the TIME/DIV to X-Y, and the CH1 and CH2 attenuators to 5mV/div. Apply a 40mV 1kHz square wave from the calibrator to the CH1 output socket. The X deflection should be 8div ±5%. Apply 50kHz from the constant amplitude generator to the CH1 input and ground the CH2 input. Adjust the generator to give a 10div horizontal line. Increase frequency until the line reduces to 7div. This frequency should be greater than 500kHz.

(o) Z Modulation
Set the CH1 attenuator to 1V/div and apply to both the CH1 input and to the Z mod socket, a 10V 1kHz square wave. Check that the blanking is operating at normal intensity levels.

SPARES ORDERING

When ordering spare parts, always give the following information:-

1) Instrument model number
2) Serial number
3) Gould part number
4) Schematic reference number
5) Description of part

In its programme of developing new and better products, Gould may make changes in component types and other parts. In most cases these components will be interchangeable with those in instruments already in the field. However, where necessary, minor modifications may be required. Contact your Gould Service Center for advice.

Most components have internationally available equivalents.

NOTE: All part numbers shown in this manual shall be prefixed with AD2, i.e., 37898 should be AD237898.

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

Resistors

CC	Carbon Composition	½W	10%	unless otherwise stated
CF	Carbon Film	$\frac{1}{8}$W	5%	unless otherwise stated
MO	Metal Oxide	½W	2%	unless otherwise stated
MF	Metal Film	¼W	1%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer			
PCP	Preset Potentiometer Type MPD, PC		20%	unless otherwise stated

Capacitors

CE(1)	Ceramic		+80% 25%	
CE(2)	Ceramic	500V	±10%	unless otherwise stated
SM	Silver Mica	350V		
PF	Plastic Film and Foil		±10%	unless otherwise stated
PS	Polystyrene			
PE	Polyester		±10%	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (aluminium)		+50% −10%	
T	Tantalum		+50% −10%	

Y AMPLIFIER

Ref	Value	Description	Tol %±	Part No.	Ref	Value	Description	Tol %±	Part No.
RESISTORS									
R200	10k	CF		21809	R251	10k1	MF		26338
R201	10k1	MF		26338	R252	1M	MF		26346
R202	1M	MF		26346	R253	470k	CC		04906
R203	470k	CC		04906	R254	10k	CF		21809
R204	10k	CF		21809	R255	10k	CF		21809
R205	10k	CF		21809	R256	22k	CP		35536
R206	22k	CP		38016	R257	470	CF		21797
R207	470	CF		21797	R258	22k	MF		36878
R208	22k	MF		36878	R259	10k	MO		28800
R209	10k	MO		28800	R260	22k	MF		36878
R210	22k	MF		36878	R261	10k	MO		28800
R211	10k	MO		28800	R262	5k6	CF		21806
R212	5k6	CF		21806	R263	220	CF		21796
R213	220	CF		21796	R264		CF	A.O.T.	
R214	2k7	CF		28726	R265				
R215					R266	2k	MO		26731
R216	2k	MO		26731	R267	10k	CF		21809
R217	10k	CF		21809	R268	10	CF		21793
R218	10	CF		21793	R269	2k2	CF		21802
R219	2k2	CF		21802	R270	220	CF		21796
R220	220	CF		21796	R271	4k7	CF		21805
R221	2k7	CF		28726	R272	3k	MO		26727
R222	3k	MO		26727	R273	150	MO		26745
R223	150	MO		26745	R274	180k	CF	A.O.T.	21822
R224	180k	CF	A.O.T.	21822	R275	12k	CF		21810
R225	12k	CF		21810	R276	3k	MO		26727
R226	3k	MO		26727	R277	47	CF		28714
R227	47	CF		28714	R278	2k2	CF		21802
R228	10	CF		21793	R279	2k	MO		26731
R229	330	CF		28721	R280	12k	MO		28802
R230	12k	CF		21810	R281	10	CF		21793
R231	56	CF		28715	R282	3k9	CF		21804
R232	10	CF		21793	R283	680	CF		28723
R233	100	CP		28520	R284	4k7	CF		21805
R234	680	CF		28723	R285	1k	CF		21799
R235	820	CF		28724	R286	330	CF	1W	19037
R236	3k9	MO	5	35823	R287	10k	CF		21809
R237	47	CF		28714	R288	4k7	CF		21805
R238	10	CF		21793	R289	1k2	CF		21800
R239	47	CF		28714	R290	10k	CF		21809
R240	6k8	CF		21807	R291	560	CF		21798
R241	33	CF		28712	R292	3k3	CC	5	18556
R242	100	CF		21794	R293	18k	MO	5 4W	35824
R243	1k	MO	5	35820	R294	330k	CC		04408
R244	3k9	MO	5	35823	R295	330k	CC		04408
R245	180	CF		21795	R296	100	CF		21794
R246	1k2	CF		21800	R297	100	CF		21794
R247	2k7	CF		28726	R298	18k	MO	5 4W	35824
R248	10	CF		21793	R299	1k	CF		21799
R249	10	CF		21793	R401			A.O.T.	
R250	10k	CF		21809	R402			A.O.T.	

Y AMPLIFIER (Contd.)

Ref	Value	Description	Tol % ±		Part No.
CAPACITORS					
C201	0.7/6pF	TRIMMER			25750
C202	0.7/6pF	TRIMMER			25750
C203	0.1μF	CE(2)		30V	19647
C204	470pF	CE(2)		125V	11492
C205	.01μF	CE(2)		500V	24902
C206	0.1μF	CE(2)		30V	19647
C207	.01μF	CE(2)		250V	22395
C208	0.1μF	CE(2)		30V	19647
C209	100pF	PS	10	160V	35807
C210	.01μF	CE(2)		250V	22395
C211	0.1μF	CE(2)		30V	19647
C212	0.1μF	CE(2)		30V	19647
C213	1000pF	CE(2)		500V	22387
C214	82pF	CE(2)		500V	22375
C215	6/25pF	TRIMMER			23593
C216	120pF	CE(2)		500V	22377
C217	120pF	CE(2)		160V	33362
C218	18pF	CE(2)	A.O.T.		22367
C219	0.1μF	CE(2)		30V	19647
C220	68pF	CE(2)		500V	22374
C221	0.7/6pF	TRIMMER			25750
C222	0.7/6pF	TRIMMER			25750
C223	18pF	CE(2)	A.O.T.		22367
C224	470pF	CE(2)		125V	11492
C225	.01μF	CE(2)		500V	24902
C226	33pF	CE(2)		500V	22370
C227	.01μF	CE(2)		250V	22395
C228	0.1μF	CE(2)		30V	19647
C229	100pF	PS	10	160V	35807
C230	.01μF	CE(2)		250V	22395
C231	0.1μF	CE(2)		30V	19647
C232	100pF	CE(2)		500V	22376
C233	220pF	CE(2)		500V	22379
C234	33pF	CE(2)		500V	22370
C235	0.1μF	CE(2)		30V	19647
C236	220pF	CE(2)		500V	22379
C237	1500pF	CE(2)		500V	22388
C238	.01μF	CE(2)		250V	22395
C239	470μF	E		6V3	32164
C240	5600pF	CE(2)		500V	22394
C241	5600pF	CE(2)		500V	22394
C242	10μF	E		25V	32180
C243	0.1μF	CE(2)		30V	19647
C244	10/40pF	TRIMMER			29483
C245	1000pF	CE(2)		500V	22387

Ref	Value	Description	Tol % ±		Part No.
TRANSISTORS					
TR201		AE31 } MATCHED PAIR			36243
TR202		AE31 }			
TR203		2N3904			24146
TR204		2N3904			24146
TR205		2N3904			24146
TR206		2N3640			31781
TR207		2N3640			31781
TR208		2N2369			33701
TR209		2N2369	ITT ONLY		33701
TR210		2N3904	ITT ONLY		24146
TR211		BF380			32902
TR212		BF380			32902
TR213					
TR214					
TR215					
TR216					
TR217					
TR218		2N3904			24146
TR219					
TR220					
TR221		AE31 } MATCHED PAIR			36243
TR222		AE31 }			
TR223		2N3904			24146
TR224		2N3904			24146
TR225		2N3904			24146
TR226		2N3640			31781
TR227		2N3640			31781
DIODES					
D201	6V8	ZENER			33931
D202	6V8	ZENER			33931
D203		IN3595			29330
D204		IN3595			29330
D205	3V3	ZENER			33923
D206		IN4148			23802
D207		IN4148			23802
D208	3V3	ZENER			33923
D209		IN4148			23802
D210					
D211					
D212	5V1	ZENER			33928
D213		IN4148			23802
D214		IN4148			23802
D215		IN4148			23802
D216		IN4148			23802
D223		IN3595			29330
D224		IN3595			29330
D225	3V3	ZENER			33923
D226		IN4148			23802
D227		IN4148			23802
MISCELLANEOUS					
IC201		SN7476N			33493
L201	68μH				35806
L202	68μH				35806
L203					04442

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TIMEBASE & X AMPLIFIER

Ref	Value	Description	Tol %±		Part No.
RESISTORS					
R101	22k	CF			21812
R102	22k	CF			21812
R103	1k2	CF			21800
R104	47	CF			28714
R105	10	CF			21793
R106	100k	CF			19061
R107	560	CF			21798
R108	220	CF			21796
R109	220	CF			21796
R110	620	MO			22485
R111	10	CF			21793
R112	390	CF			28722
R113	1k2	CF			21800
R114	3k3	CF			18556
R115	1k2	CF			21800
R116	1k2	CF			21800
R117	10	CF			21793
R118	47	CF			28714
R119	100k	CF			21819
R120	6k8	CF			21807
R121	270	CF			28720
R122	1k5	CF			21801
R123	3k3	CF			21803
R124	1M	CF			31840
R125	100	CF			21794
R126	4k7	CF			21805
R127	10k	CF			21809
R128	2k2	CF			21802
R129	120	CF			28718
R130	1k	CF			21799
R131	1k	CF			21799
R132	2k7	CF			28726
R133	1k	CF			21799
R134	8k2	CF			21808
R135	10k	CF			21809
R136	3k9	CF			21804
R137	3k9	CF			21804
R138	10k	CF			21809
R139	220	CF			21796
R140	47k	CF			21815
R141	100k	CF			21819
R142	10k	CF			21809
R143	1k	CF			21799
R144	1k5	CF			21801
R145	100k	CF			21819
R146	15k	CF			28727
R147	2M2	CC			1180
R148	68k	CF			21816
R149	2k7	CF			28726
R150	100	CF			21794
R151	1k2	CF			21800
R152	82k	CF	5	1W	19060
R153	27k	CF			21813
R154	3k9	CF			21804

Ref	Value	Description	Tol %±		Part No.
R155	18k	CF			21811
R156	100	CF			21794
R157	82k	CF			19060
R158	240	MO			28787
R159					
R160	10k	MO	5		29481
R161	100	CF			21794
R162	270	MO	2		26742
R163	1k5	MO	2		26733
R164	820	CF			28724
R165	1k5	CP			26871
R166	1k	CF			21799
R167	100	CF			21794
R168	10k	MO	5		29481
R169	2k7	MO	2		26728
R170	1k3	MO	2		28792
R171	82k	CF	5	1W	19060
R172	1k8	CF			28725
R173	100	CF			21794
R174	1k8	CF			28725
R175	1k8	CF			28725
R176	10	CF			21793
R177	27k	CF			21813
R178	27	CF			28711
R179	270k	CF			32356
R180	39	CF			28713
R181	100	CF			21794
R182	10	CF			21793
R183	10	CF			21793
R184	47	CF			28714
R185	10k	CP			38014
R186	2k2	CP			38013
R187	100k	CP			38012
R188	NOT FITTED				
R189	33k	CF			21814
R190	750	MO			28790
R191	180k	CF			21822
R192					
R193					
R194	3k9	WW	5	6W	2107

CAPACITORS					
C101	100pF	CE(2)	10	500V	22376
C102	.01μF	CE(2)	+40 −20	250V	22395
C103	10μF	E		25V	32180
C104	.01μF	CE(2)	+40 −20	250V	22395
C105	.1μF	CE(2)		30V	19647
C106	33pF	CE(2)	10	500V	22370
C107	.47μF	CE(2)		3V	35352
C108	33pF	CE(2)	10	500V	22370

TIMEBASE & X AMPLIFIER (Cont.)

Ref	Value	Description	Tol %±		Part No.
CAPACITORS					
C109	390pF	CE(2)	10	500V	22382
C110	.1μF	CE(2)		30V	19647
C111	27pF	CE(2)	10	500V	22369
C112	22μF	CE(2)		25V	32181
C113	.47μF	CE(2)		3V	35352
C114	47pF	CE(2)	10	500V	22372
C117	27pF	CE(2)	10	500V	22369
C118					
C119	4700pF	CE(2)	+40 −20	500V	22393
C120	.01μF	CE(2)	+40 −20	250V	22395
C121	100pF	CE(2)	10	500V	22376
C122	27pF	CE(2)	10	500V	22369
C128	270pF	CE(2)		500V	22380
C129	10pF	CE(2)		500V	22364
TRANSISTORS					
TR101		2N2369			23307
TR102		2N2369			23307
TR103		2N2369			23307
TR104		2N2369			23307
TR105		BC212			29327
TR106		BC182B			33205
TR107		BC182B			33205
TR108		2N2369			23307
TR109		2N2369			23307
TR110		2N2369			52527
TR111		BC212			29327
TR112		BC212			29327
TR113		BC182B			33205
TR114		BC212			29327
TR115		BF258			31490
TR116		BF258			31490
TR117		BC212			29327
DIODES					
D101		IN3595			29330
D102		IN4148			23802
D104		ZENER	8V2		33933
D105		IN4148			23802
D106		IN4148			23802
D107		IN4148			23802
D108		IN4148			23802
D109		IN4148			23802
D110		IN4148			23802

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BRIGHT UP & TUBE SUPPLIES

Ref	Value	Description	Tol %±		Part No.
RESISTORS					
R301	47k	CF			21815
R302	47k	CF			21815
R303	82	CF			28717
R304	82	CF			28717
R305	4R7	CF	5	½W	35637
R306	1k3	CF			33338
R307	1k3	CF			33338
R308	5R6	CF	5	½W	33210
R309	2k2	CF			21802
R310	2k2	CF			21802
R311	180k	CF	5	1W	19064
R312	1M5	CC			7016
R313	56k	CF			28729
R314	22k	CF			21812
R315	100k	CP			26582
R316	10k	CP			26099
R317	330	CF			28721
R318	1k2	CF			21800
R319	2k2	CF			21802
R320	499k	MF			26342
R321	10k	CF			21809
R322	3k3	CF			21803
R323					
R324	1k5	CF			21801
R325	499k	MF			26342
R326	1k	CF			21799
R327	3M3	CC			30278
R328	270k	CF			32356
R329	100k	CF			21819
R330	330k	CF			32357
R334	650k	MF	1		37006
R340	470k	CP			34296
R341	2k2	CC			21802
R342	1M	CP	Includes S1		34295
R343	220k	CF			21823
R344	10M	CC			1179
R345					
R346					
R347	820k	CF			32360
R348	1k	CF			21799
R349	100k	CF			21819
R350					
R351	22k	MO			28807
R352	150	WW		2.5W	37029
R353	33k	CF	5	⅛W	21814
R355	1k2	CF	5	⅛W	21800
R359					
R360	33k	CF			18568
R361	10k	CF			21809
CAPACITORS					
C301	1000µF	E		40V	34377
C302	330µF	E		160V	34378
C303	1000µF	E		40V	34377
C304	64µF	E		160V	34379
C305	1500pF	CE(2)	20	500V	22388
C306	1500pF	CE(2)	20	500V	22388
C307	.2µF	PF		2kV	34380
C308	.2µF	PF		2kV	34380

Ref	Value	Description	Tol %±		Part No.
C309	47pF	CE(2)		500V	22372
C310	3000pF	CE(2)		3kV	34381
C311	3000pF	CE(2)		3kV	34381
C312	.1µF	CE(2)		160V	31377
C313	.1µF	CE(2)		160V	31377
C314	.02µF	CE(2)		1.5kV	25223
C315					
C316	.047µF	CE(2)		400V	31392
C317	27pF	CE(2)		500V	22369
C318	150pF	CE(2)			22378
C319	.1µF	CE(2)		30V	19647
C320	.01µF	CE(2)			22395
TRANSISTORS					
TR301		BC212			29327
TR302		BC182B			33205
TR303		BC212			29327
TR304		BC182B			33205
TR306		BD159			34652
TR307		BC182B			33205
TR308		BC212			29327
TR309		2N2369			23307
TR310					
TR311		2N3904			24146
TR312		2N3905			20818
TR313		2N3053			4039
TR314		2N4037			21882
TR315		2N3904			24146
DIODES					
D301		IN4007			52337
D302		IN4007			52337
D303		IN4148			23802
D304		IN4148			23802
D305		IN4148			23802
D306		IN4148			23802
D307	6V8	ZENER			33931
D308	6V8	ZENER			33931
D309		IN4148			23802
D310		IN4148			23802
D311		MR250–4			32903
D312		IN4148			23802
D313		IN4148			23802
D314		IN4148			23802
D315	33V	ZENER			33947
D316	33V	ZENER			33947
D317	33V	ZENER			33947
D318					
D319		IN4148			23802
MISCELLANEOUS					
MR301		WO2			19725
SKA					34401
SKB					34401
T301					34289
S301					29057

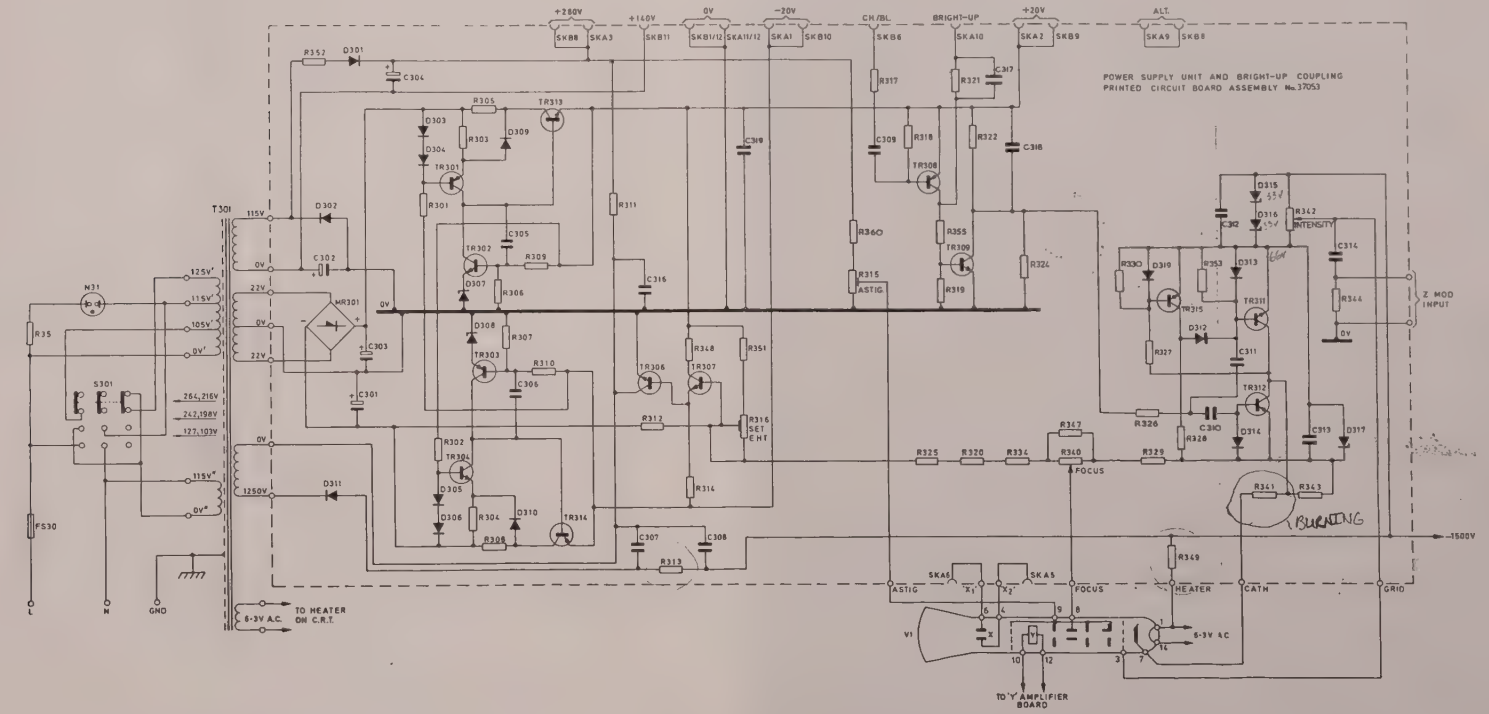

Fig. 4 Bright Up and Tube Supplies Circuit Diagram

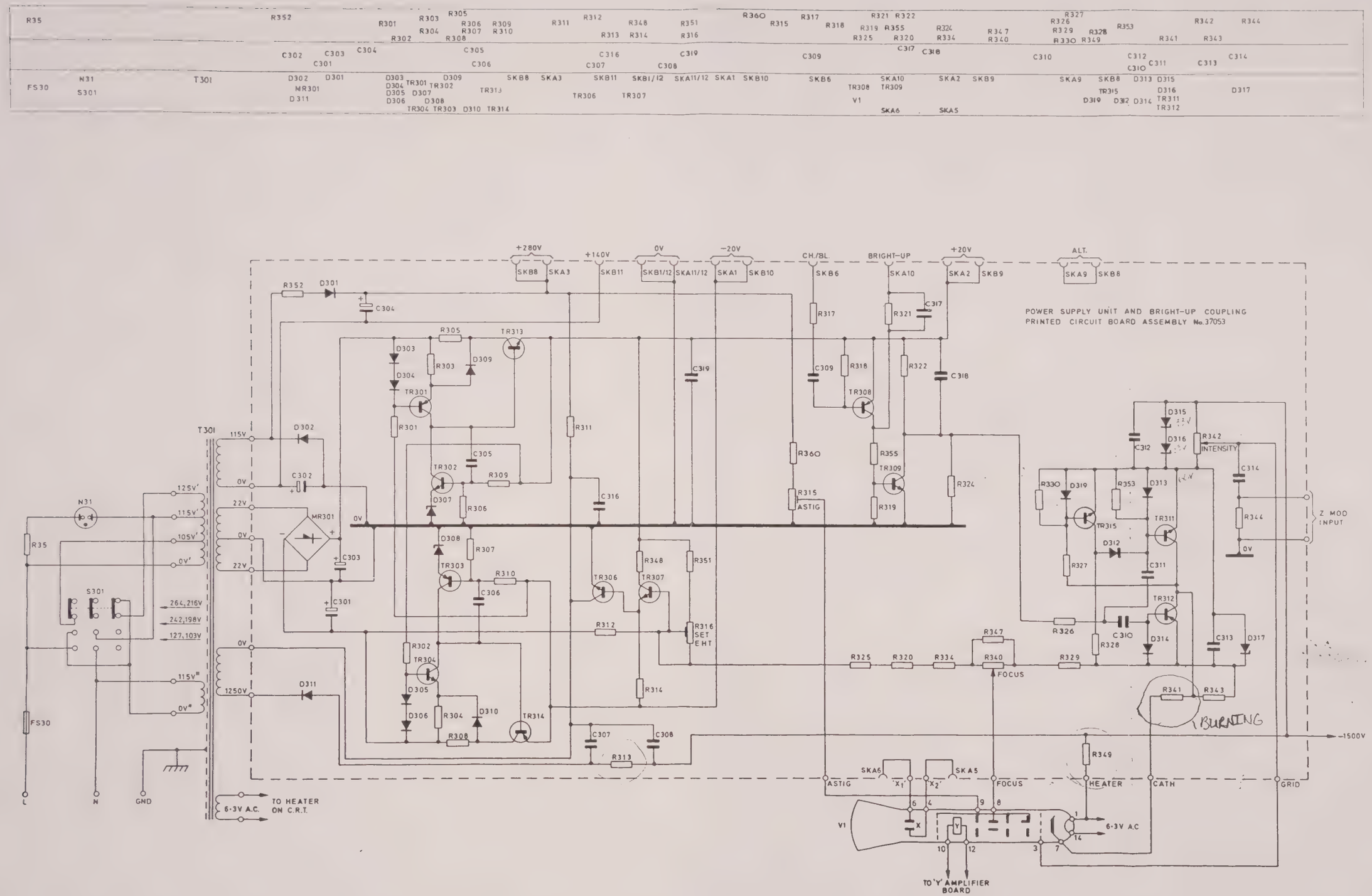

Fig. 4 Bright Up and Tube Supplies Circuit Diagram

INTERCONNECTION

Ref	Value	Description	Tol % ±		Part No.
RESISTORS					
R13-18		RESISTOR NETWORK			36455
R19	4k7	CF			21805
R20	22	CF			28710
R21	22	CF			28710
R22	18	CF			28709
R23	18	CF			28709
R24	22	CF			28710
R25	22	CF			28710
R26	990k	MF			26345
R27	990k	MF			26345
R28	22	CF			28710
R29	22	CF			28710
R30	22k	CP			38015
R31	22k	CP	Includes S27		38017
R35	68k	CF			21816
R40	16k	MF			33292
R41	15k8	MF			33291
R42	5k23	MF			33290
R43	1k72	MF			33289
R44	787	MF			33288
R45	360	MF			33287
R46	16k	MF			33292
R47	15k8	MF			33291
R48	5k23	MF			33290
R49	1k72	MF			33289
R50	787	MF			33288
R51	360	MF			33287
CAPACITORS					
C10	6/25pF	Trimmer			23593
C11	68pF	SM			34353
C12	.01μF	CE(2)	1		24866
C13	1μF	PC	2		33206
C14	.047μF	CE(2)		30V	02793
C15	4.7μF	E		63V	32195
C16	1500pF	CE(2)		500V	22388
C17	1000pF	CE(2)			22387
C21	.1μF	CE(2)		400V	29495
C22	.1μF	CE(2)		400V	29495
C23	8.2pF	CE(2)		500V	22363
C24	8.2pF	CE(2)		500V	22363
C25	47pF	CE(2)			22372

Ref	Value	Description	Tol % ±		Part No.
DIODES					
D11		IN4148			23802
D12		IN4148			23802
SWITCHES					
S1			Part of R342		A4/34295
S10					37614
S11					37613
S12					37613
S13					37614
S14					36860
S15					37614
S20					37614
S21					33724
S25					37614
S26					33724
S27			Part of R31		A4/34751
MISCELLANEOUS					
N31					26586
V1			Standard OR Long Persistence		37048 37049
SKC					01222
SKD					01222
SKE					29492
SKF					36946
SKG					24159
SKH					29492
SKJ					29492
FS30		(250mA		220V	33684
		(500mA		110V	33685

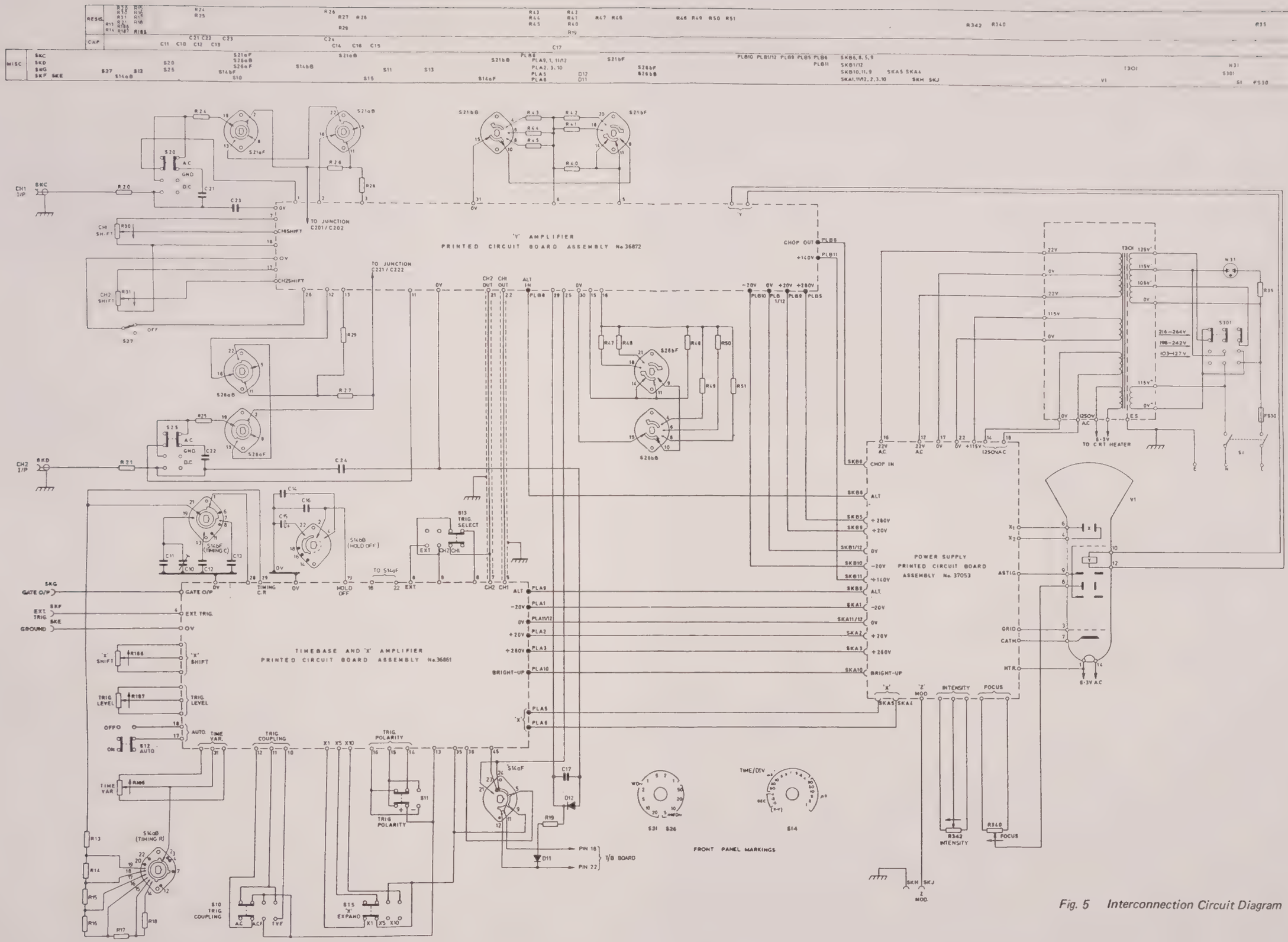

Fig. 5 Interconnection Circuit Diagram

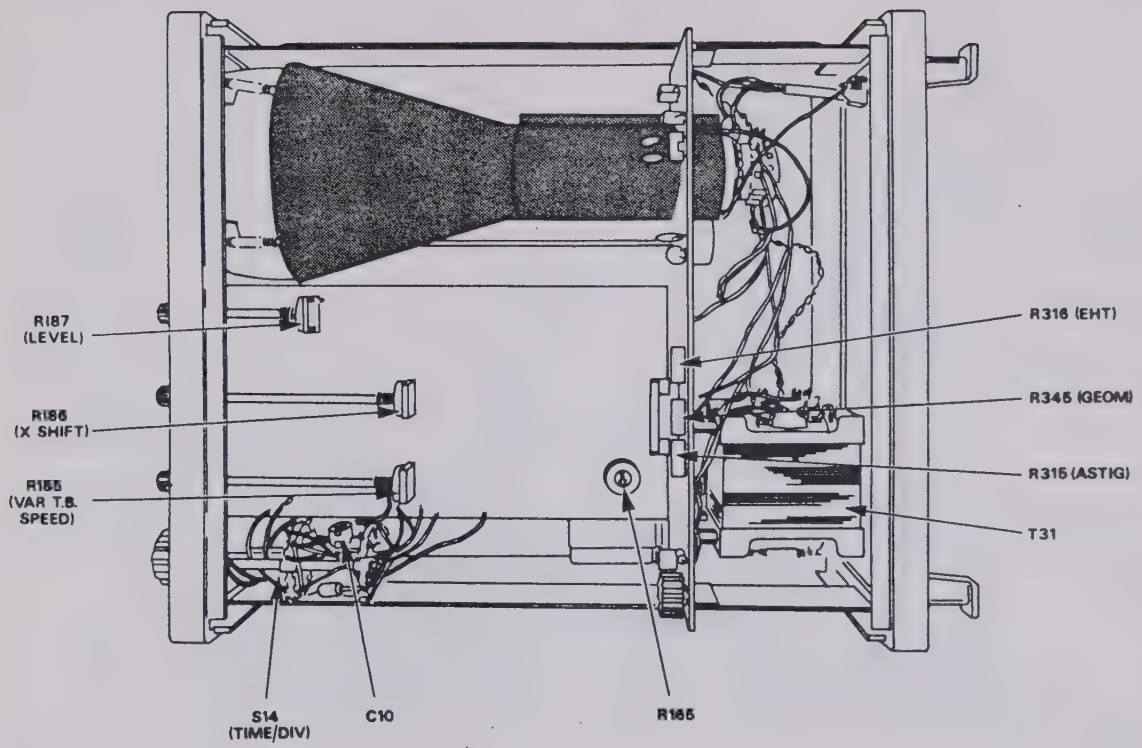

Fig. 6 Top view

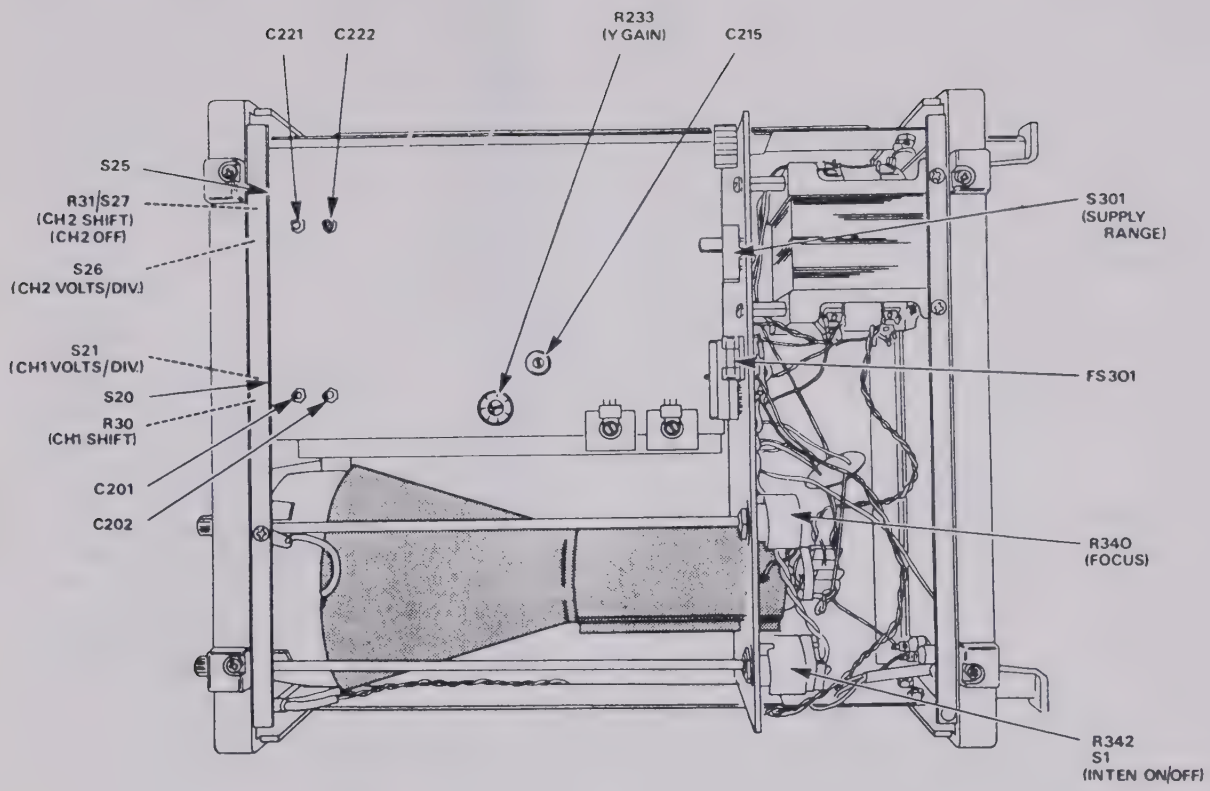

Fig. 7 Bottom view

Ref	Description	Part No
1	Frame (Front and Rear)	34276
2	Bracket Support	34275
3	Panel Front (Silk Screened) (Gould)	38761
4	Panel 'Y' Amp	37669
5	Panel Timebase	37674
6	Support Front Panel/C.R.T.	34326
7	Foot Moulded	36329
8	Panel Rear	36854
9	Foot/cable retainer	32738
10	Fuse Holder	32210
11	Cover Bottom Assy.	36856
12	Cover Top	36857
13	Handle	34284
14	Block Handle	32630
15	Circlip	32626
16	Spindle	32627
17	Spring	29206
18	Circlip	10016
19	Screw 4–40 x $\frac{7}{16}$ Pan Head	22845
20	Knob	37697
21	Screw 6–32 x $\frac{5}{16}$ C'sk Head	22771
22	Label Escutcheon	34832
23	Fuse 500mA (110V Supply)	33685
24	Screw 6–32 x $\frac{5}{16}$ Pan Head	22815
25	Washer Wavey 6–32	04590
26	Screw 4–40 x $\frac{1}{4}$ C'sk Trunc. Head	36759
27	Screw 4–40 x $\frac{3}{8}$ Pan Head Taptite	22695
28	Washer Plain 4–40	01200

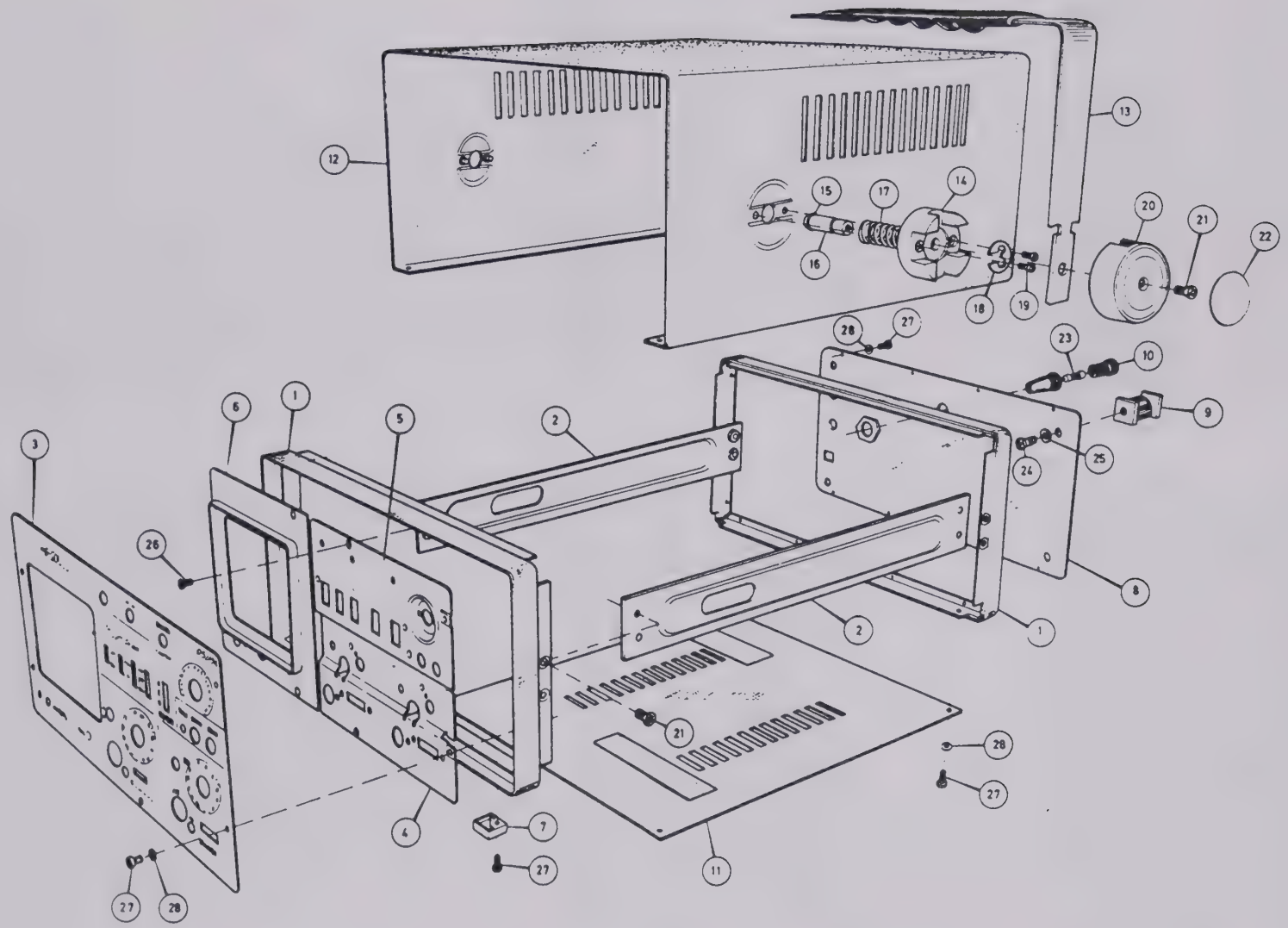

FIGURE 8 MECHANICAL VIEWS

Warranty and Service Facilities

Section 7

Gould Oscilloscopes are warranted for a period of two years from date of shipment to original purchaser. They are warranted to conform to the applicable published specifications in effect at the time of shipment, and to be free from any defects in material or workmanship.

LIABILITY OF THE GOULD INSTRUMENTS DIVISION UNDER SUCH WARRANTY IS LIMITED TO SERVICING OR REPLACING DURING THE WARRANTY PERIOD AT THEIR OPTION, ANY DEFECTIVE PARTS EXCEPT COVERS, PROBES OR FUSES AND DOES NOT INCLUDE CALIBRATION AND MINOR MAINTENANCE AS OUTLINED IN OPERATING MANUALS. IN NO EVENT SHALL THE GOULD INSTRUMENTS DIVISION BE LIABLE FOR COLLATERAL OR CONSEQUENTIAL DAMAGES.

Units are to be returned transportation prepaid by the buyer. The Gould Instruments Division will have the right of final determination of the cause and existance of a defect under this warranty. This warranty shall not apply to any products which have been subjected to misuse, improper installation, repair, alteration, neglect, accident, inundation, fire or operation outside their published maximum ratings.

PACKING INFORMATION

If the unit is to be returned for service, it must be adequately packed as follows:

a) Seal the unit in an oversize plastic bag.

b) Pack the bagged unit into a heavy duty cardboard box. The box must have a minimum of 2 inches of cushioning on all six sides, so that the unit fits snugly.

c) Any accessories or instruction manuals must be sealed into a separate plastic bag and packed with a minimum of 2 inches of cushioning between the instrument and the accessories.

d) Before sealing the box with packing tape, ensure that an official packing note is inserted, giving full details of sender's name, address and telephone number, instrument type number and serial number, plus an indication of the reason for return, and/or fault conditions, if applicable.

e) Properly label and address the outside of the box.

f) Notify Gould in advance of shipment and ship prepaid by United Parcel Service or equivalent.

Service Centers

EAST

Boston, MA
Branch and Regional Office
Third Avenue
Northwest Industrial Park
Burlington, Massachusetts 01803
Phone: (617) 272-0750
TWX: 710-322-1617

Huntsville, AL
W. A. Brown Instruments, Inc.
7917-C Charlotte Drive
Huntsville, AL 35802
Phone: (205) 883-8660
TWX: 810-726-2114

Orlando, FL
W. A. Brown Instruments, Inc.
222 Weber Street
Orlando, FL 32803
Phone: (305) 425-5505
TWX: 810-850-0146

Philadelphia, PA
Branch Office
G.S.B. Bldg.
Belmont & City Line Ave.
Bala Cynwyd, PA 19004
Phone: (215) 839-7066

Pittsburgh, PA
Campbells Run Road
Parkway West
Pittsburgh, PA 15205
Phone: (412) 923-2160

Saddle Brook, N.J.
Branch Office
74 Kenney Place
Saddle Brook, New Jersey 07662
Phone: (201) 845-0220
TWX: 710-990-5091

Washington, DC
Branch Office
5900 Princess Garden Parkway
Lanham, MD 20801
Phone: (301) 459-7350

CENTRAL

Chicago, IL
801 Mark Street
Elk Grove Village, Illinois 60007
Phone: (312) 640-4380

Cleveland, OH
Branch and Regional Office
3631 Perkins Avenue
Cleveland, OH 44114
Phone: (216) 361-3315
TWX: 810-421-8580

Dayton, OH
4668 Gateway Circle
Dayton, Ohio 45429
Phone: (513) 433-9586

Detroit, MI
23775 Northwestern
Southfield, Michigan 48075
Phone: (313) 355-0900

Houston, TX
10500 Northwest Freeway
Houston, Texas 77092
Phone: (713) 680-1121

WEST

Burlingame, CA
Branch Office
1633 Adrian Rd.
Burlingame, CA 94010
Phone: (415) 697-9345
TWX: 910-375-3314

Denver, CO
730 West Hampden Avenue
Englewood, Colorado 80110
Phone: (303) 761-7021

Los Angeles, CA
Branch and Regional Office
4601 North Arden Dr.
El Monte, CA 91731
Phone: (213) 442-7755
TWX: 910-578-4934

Seattle, WA
Branch Office
The Common Building
Suite C155
1200 112 Avenue, N.E.
Bellevue, WA 98004
Phone: (206) 453-8100

Gould Inc., Instrument Division
3631 Perkins Avenue, Cleveland, Ohio 44114
Telephone (216) 361-3315

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